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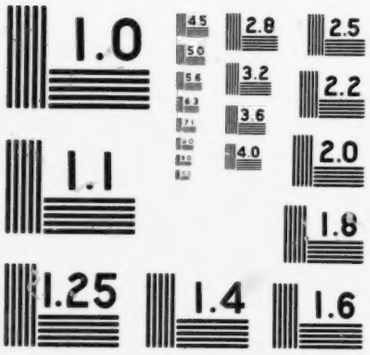

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PROGRAMMED INSTRUCTION AS AN APPROACH TO THE TEACHING OF READING, WRITING AND ARITHMETIC TO RETARDED CHILDREN.

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DESCRIPTORS- *READING INSTRUCTION, *PROGRAMED MATERIALS, *MENTAL RETARDATION, *MOTIVATION TECHNIQUES, REWARDS, READING SKILLS, WRITING SKILLS, EXPERIMENTAL PROGRAMS, CLASSROOM ENVIRONMENT, *POSITIVE REINFORCEMENT, BEHAVIOR CHANGE, ACADEMIC ACHIEVEMENT, ARITHMETIC, RANIER SCHOOL AND WHITE RIVER SCHOOL DISTRICT,

RESEARCH IN WHICH BEHAVIOR THEORY WAS APPLIED TO TEACHING READING, WRITING, AND ARITHMETIC TO RETARDED CHILDREN IS REPORTED. TWENTY- SEVEN EDUCABLY RETARDED CHILDREN PARTICIPATED IN THE CORE GROUP. THE MEAN MENTAL AGE WAS 11 YEARS AND THE MEAN IQ WAS 63. IN AN EXPERIMENTAL ENVIRONMENT OF APPROVAL, ENCOURAGEMENT, AND TOKEN REINFORCEMENT, A MOTIVATIONAL SYSTEM FOR EACH CHILD GRADUALLY EMERGED TO PROMOTE COOPERATION, EFFECTIVE STUDY, AND INDEPENDENCE. PROGRAMED MATERIALS AND PROCEUDRES FOR READING, WRITING, AND ARITHMETIC WERE DESIGNED TO REWARD CORRECT RESPONSES WITH CANDY, TOYS, AND OUTINGS. CONTINUING REEVALUATION AND REVISION OF TEACHING MATERIALS, THE VARYING AND SHIFTING OF SCHEDULES OF REINFORCEMENT, AND THE SIZE OF WORK UNITS DERIVED FROM ACTUAL CHILD PERFORMANCE PLAYED A CENTRAL ROLE IN TASKS INVOLVING SERIAL LEARNING. THE PROGRAMS ARE BEING REVISED, REFINED, AND EXTENDED THROUGH CONTINUING RESEARCH. (MC)

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PROGRAMMED INSTRUCTION AS AN APPROACH TO THE TEACHING OF READING, WRITING AND ARITHMETIC TO RETARDED CHILDREN[1,2]

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Instruction, whether aimed at developing academic skills in retarded children, increasing general knowledge in normal children; or advancing mathematical sophistication in gifted youngsters, may be conceived of as a process in which a teacher systematically and effectively arranges and rearranges an environment to bring about desired behavioral changes. Teaching on this basis, in whole or part, has been called programmed instruction (Green, 1962; and Skinner, 1963). In its most promising form, programmed instruction is a budding technology based upon an experimental analysis of behavior (Skinner, 1953, 1961, and 1964).

This paper is a report of a research in which the principles of experimental analysis of behavior and programmed instruction, (the later developed primarily on normal adults and children) were applied to teaching reading, writing and arithmetic to retarded children (Bijou, 1965; Birnbrauer, Bijou, Wolf, and Kidder, 1965). In a way, this study bears upon a technology of special education. Specifically the objectives of the investigation were: (1) to develop a motivational system for effectively strengthening academic and appropriate classroom conduct; (2) to develop programmed procedures which aim to strengthen cooperative and industrious behaviors in young retarded "educable" children who previously have shown little or no academic progress, and whose reactions to previous educational experience often range from apathy to rebellion, and (3) to develop programmed instructional materials (including teacher manuals) for reading, writing, arithmetic, telling time, handling money, and other correlated practical subjects.

This report, divided into six sections, describes (1) the children in the study; (2) the experimental classroom in which this study was conducted; (3) the motivational system developed for strengthening academic and appropriate social behavior; (4) the programmed procedures for strengthening cooperative and industrious behaviors or prerequisite academic skills; (5) the current state of the programmed instructional materials; and (6) a brief recount and account of some principles employed in developing the programs and procedures.

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The Children

Twenty-seven retarded boys and girls participated in the study to a major degree, 24 of whom resided at the Rainier School, the other 3 living at home in neighboring communities. All were subjects for a minimum of one school year, six participated for two years, and four for three years. The research objectives determined to a large measure which children would continue beyond the first year. Some children were retained as subjects so that the programs could be extended to more advanced levels: some were replaced so that revision of procedures and programs could be still further refined on different children. In selecting new subjects attempts were made to include children who: (1) had little or no prior formal education or had benefitted only minimally from previous educational experiences; (2) were a cross-sectional representation of the various clinical diagnostic catagories, and (3) had no seriously limiting motor handicaps.

Table 1 gives the chronological ages, the Peabody Picture Vocabulary Test (PPVT) mental ages and IQ's for the 27 children. The data, presented in ranges and means, are grouped according to the year of entry into the study. Thus the first-year group (1962-63) of 8 children ranged in ages from 9 years 4 months to 14 years 9 months and with a mean age of 12 years 1 month. Their mental ages were from 4 years 5 months to 9 years 6 months with a mean of 7 years 2 months and their IQ's from 44 to 66 with a mean of 59. The entire group may be characterized as having a mean chronological age of 11 years, and a mean mental age of 7 years and a mean IQ of 63.

The academic achievement previous to participation in the study ranged from upper first grade (e.g. 1.8 reading) to "not measureable" on the standard scales employed.

Eleven were diagnosed as brain-damaged, three as mongoloid, four as cultural-familial, and nine as "uncertain," unknown or undifferentiated.

Upon enrollment the classroom behavior of the children was marked by refusal to study, temper-tantrums and pouting, and by apparent cooperation but little actual accomplishment in terms of independent work. None of the children could be relied upon to stay with even a short task, no matter how short, until it was satisfactorily completed. Indeed, it is doubtful that "completeness" or "correctness" were meaningful concepts to some of them

From time to time, primarily to evaluate revisions and extensions of the programs, other children in the Institution and neighboring communities served as subjects.

The Experimental Classroom

One of the characteristics of programmed instruction is that procedures, materials and sequences are arranged to allow each child to proceed at his own rate and under conditions favorable for strengthening desired (terminal) behaviors. These requirements present one of the first practical problems in setting up the study - namely, how to have each child follow his own individual schedule in a productive manner and without interfering with the learning activities of the others. While this problem might be solved by utilizing a laboratory classroom similar to a university language laboratory, in which each pupil studies in an individual study booth, such an arrangement would not contain the ingredients necessary for training children to study in a group setting, as in the typical classroom, the library, or the home. The plan of the classroom-laboratory shown schematically in Figure 1 was designed to provide a setting conducive to carrying out this objective.

The classroom proper consists of six student desks, three tables for writing exercises, and two general-purpose or work tables for assignments requiring large working areas and for material and equipment storage. The three individual study rooms at the upper end of the diagram are separated from the classroom by curtains, providing observational space for visitors. Programs requiring considerable concentration and/or involving auditory stimuli such as reading, are presented in these single rooms; work in writing and spelling, and practical exercise are conducted in the classroom proper. There is, in addition to the areas shown in the diagram, a room which serves as an office, a data processing room, and a place to prepare and store materials.

The waiting area was used to help establish the classroom as a place for quiet, productive study. From the first day, the Children were met in the waiting area by a teacher who instructed them to sit down, and reinforced them both socially and with tokens for sitting quietly and for engaging in "small talk." They remained in the waiting room until given permission to enter the classroom. If at any time a child entered the classroom without permission, he was reminded that he should be in the waiting room. If he behaved disruptively, he was placed in the "time-out" room. (An account of the general use of the "time-out room" is given in the section on the programmed procedure for strengthening "study habits.") The interval spent in the waiting area allowed the children to greet one another and the teachers, to talk about recent events, and in general, to "settle down" before entering the classroom. Under these circumstances it would be more probable that

entering the classroom would come to serve as a cue for starting to work immediately on the assignment for the day.

Development of a Motivational System for Strengthening Academic and Appropriate Social Behavior

Initially, the teachers attempted to strenghten desirable classroom behavior and correct answers to academic materials by following such behaviors with remarks of approval and by ignoring inappropriate responses. Little, if any, improvement in sustained studying behavior was obtained under these procedures. Evidently verbal remarks in the form of approval and praise did not have reinforcing functions for these children. Consequently, a token reinforcement system similar to that used by Staats, Schutz & Wolf (1962) was added. This procedure did indeed establish and maintain higher rates of effective study and greater cooperation. It was also expected to increase the strength of teacher's comments of approval and praise as conditioned reinforcers since they were always given in conjunction with the delivery of tokens (Bijou & Baer, 1961 and 1965, Skinner, 1953).

Colored gummed stars which served as tokens during the first year were subsequently replaced by "marks" (short diagonal strokes) entered by the teachers in squares on one page of a three page booklet which each child carried with him. "Marks", always preceded or accompanied by some comment of approval or praise, were given in proportion to the number of correct answers to items in the programs; bonus marks were given for especially cooperative behavior and error-free assignments. This system was decidedly less time-consuming to administer than stars and seemed just as effective.

When a page was filled with "marks" it could be exchanged for trinkets, candy, pencils, money, or for credit toward a larger sum of money and a privilege of spending it in town or on a special outing or trip. The number of "marks" on a completed page determined its value. Some children earned the equivalent of about one cent each day, while others averaged about a nickel every two days.

The reason for using a three-page booklet and entering marks on all pages concurrently was to reduce the likelihood that the child would lose "interest in school work" or even engage in disruptive behavior following the completion of a page. There was seldom a blank page in the booklet and the child could anticipate another full page within a short time if he continued to work. By this procedure, a relatively consistent and highly productive type of performance was achieved. This phenomenon-work stoppage after reinforcement - is often observed in the every day behavior of students and employees, and is well documented in the data from experimental laboratory studies (e.g., Ferster & Skinner, 1957).

[illegible] the class [illegible] [illegible] [illegible]

to work continually. Delayed reinforcement for correct responses was introduced only when there was a high probability that the child would maintain his accuracy and complete the task. The length and number of assignments to be performed independently were then gradually increased.

Placing a child in a group learning situation naturally generates behavior incompatible with academic learning. The traditional procedure for dealing with such behavior was employed, however it was systematically programmed. For example, a child was instructed to raise his hand to obtain permission to talk. Talking without permission was not responded to (extinction) unless the child was new to the class in which case the teacher would prompt him into making the desired response by saying something like, "Raise your hand if you wish to ask a question." The teacher would then wait until the child responded as requested and then reinforce him with attention and perhaps an extra mark.

If the social situation of the classroom generated severe disruptive behavior other procedures were used. During the first year of the study, attempts were made to weaken these behaviors by ignoring them (extinction). This plan proved effective only for some children, so another approach was explored and developed. Referred to as the "time-out" procedure, it involved removing the child from the classroom contingent upon inappropriate behavior. Specifically, the time-out procedure (time-out from positive reinforcement) was used if the child (1) engaged in aggressive behavior (hitting, biting, kicking, etc.) toward another pupil, teacher, or visitor, or (2) refused to comply with a teacher's instructions. If a child engaged in either of these behaviors he was given the choice of stopping immediately and returning to his work, or leaving the room. If he chose to persist in the disruptive behavior he was placed in the "time-out" room for ten minutes. At the end of this ten-minute period, if he had been quiet for the proceeding 30 seconds, he was told he could return to his work. In most instances, when a child was given the choice between returning to work or leaving the classroom he usually chose the former; hence the "time-out" room was used infrequently, i.e., about six times a month during the first year and about two times a month during the second year. At present it is rarely used. In agreement with research findings, the "time-out" procedure was found to be a faster and more permanent way of eliminating disruptive behaviors than extinction (Holtz, Azrin, Ayllons, 1963; Wolf, Risely & Mees, 1964).

The terminal prerequisite academic behavior is best described in terms of the behavior of the advanced student. Instead of being given his assignment by the teacher, he obtained his own "work folder", set his own watch, entered the date and starting time on his daily record sheet. He chose his first task, completed it, and went on to the next. Starting and

finishing times entered for each item. When all the work was completed, he called a teacher and together they checked his work. Marks were given at this time.

About one-third of the children studied reached the degree of independence described above. The amount of time required to achieve the terminal behavior varied. For example, three children were able to work independently in less than a year, one required a year-and-a-half. Because most of the children were in the program for only one year, it is impossible to say whether all could have reached the status of the "advanced students" and how long it would have taken each to do so.

The Development of Instructional Materials

The major concern during the first year of the project were the development of an effective motivational system and a programmed procedure for strengthening prerequisite academic behaviors. These problems had to be solved, at least tentatively before concerted effort could be devoted to programming academic learning. However, in order to initiate the study it was essential to have at least tentative materials to make up a curriculum. Hence attempts were made from the start to prepare programmed academic material and procedures, but at times the research on motivation and on the shaping of "study habits dictated the type of academic materials needed and the rate at which they would be introduced. This, then, is a brief description of the programmed materials developed in the first stage of the research. Currently they are being extensively revised and extended.

Three considerations influenced the development of materials and procedures for reading, writing and arithmetic. First, all were planned to be serviceable for individual instruction. Second, new materials and new procedures were introduced as the child met certain necessary behavioral and academic prerequisites. Third, the work a child was given was planned to be as close as possible to his level of competence. An assignment and record sheet for each child was prepared every day. It listed the material to be covered and provided space for responses to the items and time spent on each task. The work sheet together with the necessary materials, made up each pupil's "work-folder." At the end of the day, data on the record sheet showing the number of correct and incorrect responses and the time required to complete a task served as a guide for the preparation of future assignments. For example, if a child's error rate on a particular task was low (e.g., below ten percent) the next set of related material would be placed in his folder for the next class. If his error rate remained high (e.g., above fifteen percent) over several sessions, the material would be revised and represented at the earliest time possible.

The major academic program--reading, writing, and arithmetic--consisted of several sequences which were presented concurrently, and each was designed not only to teach specific terminal behaviors but also to contribute to the child's progression in the other programs. For example, one program involved instructions in time-telling, a skill which involves number recognition, discrimination between the lengths of the clock hands, and writing and reading numbers. Therefore, the arithmetic program began with recognition of the numbers zero to nine, and the introduction of the concepts of addition, subtraction, and discrimination of "greater than" and "less than". Computation was limited to numbers under 20. To relate the writing program to the others training began with the writing of these numbers. The next step of the number recognition program presented only the "fives" through 60 so that the time-telling program could be started when this sequence was completed. Review of the "fives" and the numbers in-between was programmed to take place while the child was working on the "time-telling" sequence.

Each child started on a "discrimination program" which develops a discrimination repertory similar to reading and arithmetic "readiness" training (Holland, 1960; Skinner, 1961). The program required the pupil to select the letter group, geometric form, or numeral that matches a sample, from choices which increases in similarity to the correct answer. These materials were presented on a simple manually-operated teaching machine (Min/Max). When the child learned to operate the machine properly and had completed the discrimination program, he was introduced to the other program sequences, thus making program evaluation less complex.

Reading

There were three interrelated beginning reading programs. The first was a Sight Vocabulary Program (SVP) designed to teach the reading of words, phrases, and sentences. Two types of items were programmed; Discrimination or choice items in which the child was required to circle the correct word in a four choice situation, and construction items in which the youngster was expected to make vocal response. Initial correct responses were reinforced with a mark. Correct responses following incorrect responses on the same item were not so rewarded. The words used in the SVP were selected from all parts of speech, primarily on the basis of their assumed familiarity to children in a residential school and the ease with which they could be combined into sentences (Staats, Staats, Schutz & Wolf, 1962).

The second reading sequence consisted of two Comprehension Programs intended to instruct the child in the meaning and use of the words in the Sight Vocabulary Program. The tasks consisted of (1) matching printed materials with pictures, and (2) silent reading followed by answering questions or carrying out directions.

In the picture-matching sequence, the task for the child was to read silently a word, phrase or sentence printed on a card and then to place the card on the appropriate picture. In one comprehension sequence the child read simple statements in a booklet and responded to multiple choice questions on the material. On the other comprehension series, he also read simple statements in a booklet and then followed the directions. This task was designed to be more complicated than the first in that it required integration of several previously learned skills. In this program the child was given a booklet, several containers with objects (e.g., circles, numbers, small plastic horses, boys, girls, cars, etc.), and a number of empty boxes. The booklet contained such statements as "Put 5 green cars and two black horses in box 4."

The third sequence consisted of a simple phonetic sequence designed to present a phonetic alphabet consisting of only short vowels "hard" consonants, and blends. In this program the child was first required to respond to the visual presentation of each letter by vocally making the equivalent sound, and later to select the correct sound from a group when the letter name was presented vocally.

Writing

At the outset, the writing program used an illuminated tracing box to initiate writing skills (Birnbrauer, Bijou, Wolf & Kidder, 1965.) This procedure, which presented or withdrew the model to be traced by light control, was introduced on the assumption that initial training in tracing lines, letters, and words provided the child with continuous and immediate information as long as the model was clear and the child could compare his strokes to the model. In addition to ensuring model clarity, the illumined box permitted "weaning" of the child from tracing by gradually decreasing the proportion of time during which the model was illuminated. Simultaneously, the model increased in complexity, from the component strokes which make up cursive letters to complete words, and the error tolerance was decreased.

In the next stage of the research on writing, the illuminated tracing box was eliminated. Instead of starting with attempts to shape tracing skills, the program started with whatever copying behaviors the child displayed. The printing of letters was then introduced. Later in the program the child was required to use cursive writing when "copying" printed material or when doing any writing. There were several reasons for this revision in procedures, one being that transfer from tracing to copying frequently failed to occur. Some combination of tracing and copying from the outset seemed a more effective approach.

Arithmetic

The arithmetic program began with matching dots or objects with numerals, counting aloud, and putting numbers in their proper order. (If a child could not discriminate, name, and write numbers, he was given training in the writing program designed to develop these responses.) Next, simple addition operations were introduced. An example from this sequence is shown in Figure 2. The next program consisted of material on the concepts of "greater than", "less than", "equal to", all of which were presented by the "dot-numeral" approach. After that came sequences on simple subtraction and addition facts. At the same time, another series was offered designed to teach ordering numbers from 1 through 60.

As soon as a child showed he could read simple instructions, sequences in arithmetical reasoning problems were presented. Carrying, multiplication, division, and more advanced arithmetical comprehension tasks were introduced in a similar gradual fashion in subsequent sets. Training in the discrimination of monetary values was given in a separate sequence after the child had learned the prerequisite knowledge. Training in telling time to the criterion of adequate oral and written responses also constituted a miniature program as was mentioned earlier.

Some Principles

In this final section we shall attempt to make explicit the main principles which guided the development of the programmed procedures and materials. Two preliminary comments are in order; one pertains to the current status of the principles of programmed instruction; the other, to the research methods we employed. With respect to principles, one can distill only a few reliable propositions from this decade's profusion of literature on programmed instruction. Many statements presented as principles, turn out, on close scrutinity, to be assumptions, definitions, analogies, or only partially demonstrated functional relationships. In light of this state of affairs and the relative newness of applying behavioral principles to academic learning, it is more realistic to view this as summing

up not so much a discussion of principles as a discussion of guidelines, or tentative formulations derived from our experiences with retarded children and from the writings of others working with normal subjects. (e.g., Green, 1962, Holland, 1960; Skinner, 1961, 1963, and 1965).

With respect to the research method used in this study, the strategy was not unlike that of constructing psychological tests. The essential difference was that instead of focussing on creating stimulus materials that would yield differences between groups, we attempted to prepare stimuli that would enable a child to acquire progressively more complex skills and knowledge. The method consisted of (1) preparing tentative procedures and programs based on general information from teaching experiences and the literature, (2) evaluating these materials on the performances of a small sample of children observed one-at-a-time and in a one-to-one situation, (3) revising them on the basis of the child's performance, (4) readministering the new versions to the same or a similar group, and (5) reevaluating and revising them again on the basis of the second administration. This format was continued until each child reached a criterion of progress set in terms of error rate, or a combination of error rate and another measure, such as performance on similar material (generalization).

Guidelines for the Development of the Motivational System

There is good reason to believe that learning with positive reinforcement contingencies lead to better maintenance of learned behavior and avoids some of the undesirable behavioral consequences of contingent aversive stimulation. Therefore the major guideline adhered to in the development of the motivational system was that instruction be based on positive reinforcement. As we pointed out earlier, we quickly observed that the children in this study were not sensitive to the contingencies usually employed by the teacher (e.g., giving differential attention, praise, social recognition) consequently it is necessary to contrive a workable motivational system. For several reasons, a token system was decided upon: first, "marks" can be dispensed rapidly and generously at very little cost; second, administering them does not interfere with studying behavior; third, they can be given on any time schedule; and finally, and most important, they allow each child to earn the kind of object or activity (the back-up reinforcers) most reinforcing for him personally, there are added advantages. By shifting schedules of reinforcement and the size of work unit required to earn a token, and by varying the number of tokens required for back-up reinforcers, the teacher can dispense tokens in quantities most effective at the different stages of mastering a program (Birnbrauer & Lawler, 1964). Furthermore, the teacher can dispense the reinforcers at the proper time and in the proper amounts by utilizing simple teaching machines and ingenious arrangements of teaching materials.

The system of giving "marks" entailed three components: (1) The marks must be given as soon as possible consequent to the specific behaviors to be strengthened, (2) They must be given for increasingly larger units of behavior, (3) They must be given simultaneously, or almost so, with social stimuli from the teacher.

1. Giving "marks" as soon as possible consequent to the specific behaviors to be strengthened. A functionally defined reinforcer has its greatest effect when it occurs close in time to the occurrence of the behavior to be reinforced. Hence simple teaching machines, such as the Min/Max, and other instructional techniques were employed to close the temperal gaps between response and stimulus occurrences at least in the initial stages of learning. As learning progressed delays of adminstering the reinforcers were gradually increased by employing techniques of constructing "bridges" of conditioned reinforcers spanning the time between the response to be reinforced and the occurrence of the token reinforcers.

2. Giving 'marks" for increasingly larger units of behavior. Marks for appropriate social behavior, were given first on a continuous reinforcement schedule, then, at a pace set by the child, on gradually increasing intermittent schedules. Marks for correct academic responses were given for correct responses to longer and longer sequences of academic material. These procedures of making contingencies systematically more infrequent not only prolong the effectiveness of reinforcers and increase resistances to extinction, but also contribute to developing the desired academic behaviors, e.g., reading words, phrases, sentences and then paragraphs.

3. Giving "marks" in close association with other stimuli. One of the consequences of a reinforcing interaction is the emergence of new conditioned reinforcers. Thus, when a token is delivered by an individual, the stimuli present at that moment (the appearance of the person, her facial expression, the words she utters, etc.) can acquire conditioned reinforcing properties. Thus "marks" were given with a smile or a comment such as "that's good," or "Yes, that's right." Effort was also made to make the products of learning, conditioned reinforcers (intrinsic reinforcers) by giving tokens and praise for concrete evidence of advancement in academic achievements such as a well-written word, sentence, or paragraph.

Guidelines for Developing Prerequisite Academic Behaviors

As previously described the main guideline for the establishment of serviceable prerequisite academic or study behavior involved a two-pronged approach; (1) strengthening the desired classes of behavior, and at the same time, (2) weakening those behaviors which compete with the desired behavior.

The main technique for strengthening appropriate study habit behavior was differential reinforcement of successive approximations to the criterion behavior.[3] In essence, this approach uses a shifting behavioral criterion for reinforcement, one that has the characteristic of gradually approximating the form of the desired behavior. Obviously, this shaping procedure can not be carried out effectively unless the contingencies are meaningful to the child (i.e., are functionally defined), and the teacher is capable of discriminating the progressive succession of responses involved, beginning with the responses during initial training and ending with those that define the terminal behavior. If the teacher cannot discriminate the steps, she cannot deliver the reinforcers appropriately; as a consequence she will fail to build up the strength of the desired behavior beyond that of the undesired behavior.

Let us say that the study behavior of a child in this investigation consists of four segments. (1) Getting ready to start the day's assignments. To strengthen this sequence the child would be reinforced in turn for entering the classroom and walking directly to the table where the assignment folders are kept, picking up his folder, going to his desk, sitting down, setting his watch, opening the folder, obtaining the materials necessary for doing the first assignment, recording the starting time on the answer sheet, and starting to work on the first item. (2) Working on the first assignment. Here the youngster would be reinforced for carrying out the instructions, for paying attention to the confirmations, and for working more and more productively. He would also be reinforced for raising his hand when he requires assistance from the teacher. (3) Terminating an assignment and preparing for the next one. Reinforcement would be forthcoming for recording the time at which he finished the assignment, putting away materials, and preparing for the next task. Preparation for the next task could consist of going to the "directions" table, a writing table, or into one of the tutorial rooms, and gathering the materials he will need for working there. As in the first phase, reinforcements would be given for recording time and for starting promptly. (4) Increasing productivity during the class period. Extra reinforcers would be given for reduction in the number of errors and time required for a single assignment, then for several assignments, and then for all the assignments of the day. The criterion for determining when reinforcers should be given for increased productivity would be, of course, the child's previous performance.

The guideline involving the use of contingent "time-out" from positive reinforcement was predicated on the assumption that events in the classroom are in fact positive reinforcers for each child. If classroom events are not positively reinforcing, if the stimuli in the classroom have negative reinforcing properties for him, then removal of the child from this situation would seem to strengthen rather than weaken the preceding disruptive behavior (Skinner, 1953). In a study by Birnbrauer, Wolf, Kidder, and Tague

(1965) on the effect of the token system, they found that when the token procedure was eliminated, not only was the "time-out" room used more frequently but two children overtly competed to go there. The authors state: "It appears that the removing of a child from a classroom is effective to the extent that it is, in fact, time-out from positive reinforcement. Complying with classroom expectations must be more reinforcing, one way or another, than the alternative" (p. 232).

Earlier we described the "time-out" procedure as being initiated by the teachers comment to the child that continuation of his disruptive behavior would result in his removal from the classroom; disregard of this reminder was followed by his removal. Pairing of a verbal statement, "If you continue to behave like that you will have to go to the 'time-out' room," with the act of taking the child to the "time-out" room eventually gives such a statement the property of a conditioned aversive stimulus and as such becomes effective when used alone.

Guidelines for the Development of Programmed Instructional Materials.

The preparation of the programmed instructional materials was based on certain general assumption which can be expressed in terms of the following general guidelines;

1. Reading, writing, arithmetic, and academic exercises based on these subjects are operant interactions. Therefore academic responses are strengthened, weakened, and elaborated in accordance with operant principles, and the educational environment should be engineered to provide for the appropriate arrangements of antecedent (cue, or discriminative) stimuli, contingencies, and setting events (Bijou & Baer, 1961).

2. Academic learning consists of changes in a child's performance in relation to events which make up his educational environment. Hence an academic environment should stimulate the child to react in an explicitly defined manner to the material to be learned. Therefore, attempts were made to arrange the learning situation so that reactions to cues, to instructions, and to contingencies were readily observable and recordable. This guideline does not imply the acceptance of a theoretical position which implies that academic learning takes place only when overt behaviors are in evidence. Obviously academic learning includes all sorts of unobservable behavior. The main reason for engineering the classroom situation so that responses were readily observable and recordable was to provide data for systematic evaluation of the materials and procedures.

3. Progress in academic learning depends upon the child's history with respect to previous academic interactions and the current academic environment functionally defined, i.e., defined in terms of the meaning of the environment as judged by the child's reactions to it. Hence extensive efforts were made to individualize the learning situation so that each child would work on tasks appropriate for him and fairly independent of teacher supervision.

4. Advancements in academic learning are achieved by systematically presenting materials which gradually require more and more complex behaviors. Therefore efforts were made to design programs which would allow each child to start at the level of his subject competence, as determined by pretests, and advance to materials requiring progressively more complex interactions. When we refer to progressively more complex interactions we are referring to responses to more complicated discriminative stimuli (words, phrases, and sentences), and to more subtle discriminative stimuli (the word "light" first has only one meaning, then different meanings depending on the context in which appears). This term also refers to responses with increased differentiation (writing with greater ease and skill), and to larger repertories of responses to the same stimulus event (saying, writing, spelling, sounding out and telling the meaning of the word "boat").

The discussion above covers the general guidelines which influenced the preparation of the academic programs and procedures. We turn now to some specific considerations.

1. Training in making discriminative responses should precede training in making constructed responses in sequencing programmed instruction material. For example, before a child is required to say or write a word, he is given training in discriminating that word from others which resemble it by pointing, touching, or marking the correct word, etc. Beside this requirement, attention was given to the position in which each item was presented, initially and on succeeding occurrences.

2. Training in the acquisition of knowledge (responding to textual material, naming objects, describing relationships, ordering stimulus material, etc.,) should follow fading procedures. Basically such training involves bringing academic behavior under the control of substitute stimuli. Sometimes the surrogate cues are some aspect of the stimulus materials; sometimes they are produced by the behavior of the child. For example, a child is asked to say "house" when he is presented with a picutre of a house, the written word "house", and the spoken word, "house" is given by the teacher directly or on a tape. The stimulus properties of the picture of the house and the spoken word are gradually reduced until the child says

"house" when presented with only the written word. Discoveries of the most advantageous ways of systematically fading the stimulus supports constitute a large segment of the reading program.

3. Training in motor skills should follow shaping procedures. Shaping was the primary basis for teaching writing. In many instances training started with reinforcing the child for holding a pencil with the right amount of firmness (intensive characteristics), and for forming preletter strokes, then writing letters and numbers in crude forms. In the advanced stages a combination of shaping and fading procedures were involved. Fading procedures were used to remove cue support from tracing and copying from visual models, and in shifting from copying from models to writing from dictation.

4. Opportunities to use learned responses should be made available in increasingly complex situations within the program as well as in other related programs.

5. Since retarded children frequently have specific behavioral deficiencies that prevent consistent progress, supplementary short sequences, designed to produce the missing repertories, should be made a part of programmed instruction. In such cases, the special sequences are based on diagnostic findings derived from the child's actual performance.

6. The concept of stimulus-response chaining should play a central role in tasks involving serial learning. Guidelines on how chains are extended and strengthened and made into multiple systems were particularly influential in the arithmetical programs.

7. Training in the use of self-prompting techniques should be a part of programmed instruction. For example, after the child had acquired sight vocabulary consisting of single words, simple phrases, and sentences, he was given training in discriminating the sounds of vowels, some consonants, and simple blends of consonants. This phonetic training was included in the reading program in order to enable the child to "sound out" words he did not recognize on presentation.

Summary

This paper is a report of research in which behavior theory was applied to teaching reading, writing, and arithmetic to retarded children. The specific objectives of the study were: (1) to develop a motivational system that would be effective for each child, (2) to develop programmed procedures for the establishment of study behavior, and (3) to develop programmed instructional materials for reading, writing, and arithmetic.

Although many children participated in the study since its inception in 1962, the core group consisted of 27 boys and girls ranging in chronological ages from 3 years 7 months to 14 years 9 months. Their Peabody Picture Vocabulary mental age ranged from 3 years 8 months to 10 years 6 months their IQ's from 39 to 87. The average child of the group was 11 years old and had a mental age of 7 and an IQ of 63.

The children had a variety of clinical diagnoses, were low in academic achievement and poorly motivated for further school advancement.

The study was conducted in a classroom-laboratory shown schematically in Figure 1.

Initial efforts were devoted to developing the motivational system, the final form of which consisted of tokens exchangeable for candy, toys and social outings. Tokens were given in association with complementary comments from the teacher to strengthen social reinforcers.

Study behavior was made progressively more effective by reinforcing classroom behavior that would gradually approximate the ultimate kind of supporting behaviors necessary to learn academic subjects in an effective manner.

The main effort during the second two years of the study was devoted to the construction of instructional programs in reading, writing, arithmetic, and correlated practical subjects. Programs began with pre-academic materials and became gradually more complex based on findings from the repeated performances of the children. The programs are still being revised, refined, and extended.

The final section of this report brings together in explicit form the guidelines employed in the investigation. These are presented not as a finite member of well established principles but rather as the tentative principles that have influenced the general strategy and the specific procedure followed. They are offered in explicit form so that they may be revised and extended by future research.

Table I

Chronological age, Peabody (PPVT) mental age and IQ# of the children

grouped according to the year they entered the project

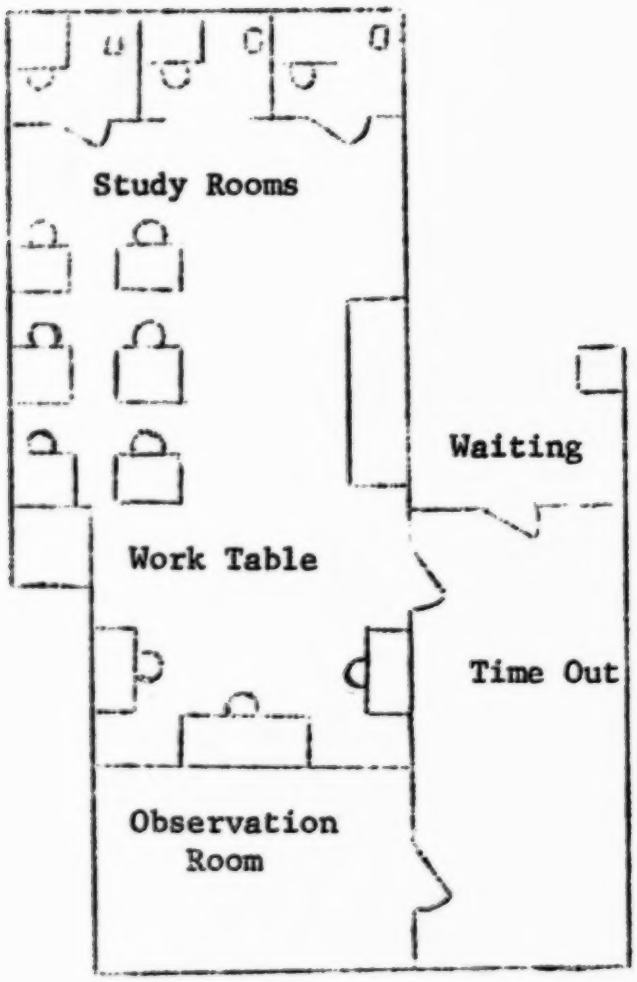
1962-63		1963-64		1964-65	
N=8		N=9		N=10	
Range	Mean	Range	Mean	Range	Mean
CA 9-4 to 14-9	12-1	8-7 to 12-0	10-4	8-10 to 11-4	10-2
MA 4-5 to 9-6	7-2	4-10 to 10-6	7-0	3-8 to 9-8	6-3
IQ 44 to 66	59	56 to 87	66	39 to 93	65

#Two of the scores were from the Wechsler Intelligence Test for Children, and one from the Stanford-Binet Intelligence Scale.

Figure Captions

Figure 1. The components of the Rainier School Experimental Classroom.

Figure 2. A sample of the arithmetic program.



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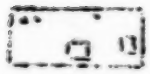
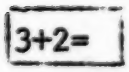
Item 1				
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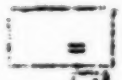
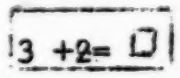
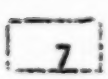
Item 2				
Answer	...	4	 5	
Item 3				
Answer	.....	5		